Taylor; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Havana, presented by Mr. Arthur Morris; a Chimpanzee (*Anthropopithecus troglodytes* ♂) from West Africa, a Bison (*Bison americanus* ♂) from North America, an Anaconda (*Eunectes murinus*) from South America, deposited; a Brazilian Tapir (*Tapirus americanus* ♀) from South America, four Hairy-rumped Agoutis (*Dasyprocta prymnolopha*) from Guiana, a Mexican Agouti (*Dasyprocta mexicana*) from Mexico, four Scarlet Ibises (*Eudocimus ruber*) from Para, a Blue and Black Tanager (*Tanagrella cyanomelæna*) from South-East Brazil, a Prince Albert's Curassow (*Crax alberti* ♀) from Columbia, purchased.

OUR ASTRONOMICAL COLUMN.

CORDOVA OBSERVATORY.—A publication of some importance has recently been issued from the Observatorio Nacional Argentino. It contains the observations made under the direction of Dr. Gould, in 1880, for the General Catalogue, arranged and published by Mr. J. M. Thome, the present Director of the Observatory. The mean places of 10,923 stars have been found from 33,837 separate and complete determinations, and this during one year of observation. In addition, 1613 observations of circumpolars, and 1738 of time-stars, have been made for determining instrumental corrections. It is therefore well remarked that "the dimensions of the volume almost entitle it to the rank of a General Catalogue, and the results for the month of December alone, when 5938 determinations of positions were made, would form a fair Annual Catalogue." In order to get through this immense amount of work, the meridian circle was manned with an observer, a microscope reader, who also pointed the telescope, and a recorder; and on four nights of eight hours each, in December, these three observers made, on the average, 1549 complete determinations. And the work has been done in such a thorough manner, in spite of the rapidity of execution, that one cannot but admire the dexterity of Messrs. Bachmann, Davis, and Stevens, who have assisted Mr. Thome. The right ascensions are referred to the "Standard Places of Fundamental Stars," second edition, published in 1866. The mean places of these stars for the beginning of each year, to 1880 inclusive, are published in the American Ephemeris tables, and their apparent places in successive volumes. The magnitudes recorded in the Catalogue are generally the results of estimation. Stars, however, which occur in the "Uranometria Argentina" have had their magnitudes taken from the data collected for that work. Catalogues of southern stars are hardly so plentiful as those containing places of stars north of the equator. This volume is therefore doubly welcome. It represents work carried out in spite of the vicissitudes to which an Observatory in the Argentine Republic must be subject, and the results obtained will be appreciated by all.

ALGOL.—In a series of contributions to the knowledge of the variable stars, which has appeared in the *Astronomical Journal*, Dr. S. C. Chandler has discussed the periods, motions, and laws of variable stars. His last communication, contained in Nos. 255 and 256 of the *Journal*, deals with the inequalities in the period of β Persei; the theory which satisfactorily accounts for these and other phenomena being stated as follows:—"Algol, together with the close companion—whose revolution in 2d. 20·8h. produces by eclipse the observed fluctuations in light, according to the well-known hypothesis of Goodriche, confirmed by the elegant investigation of Vogel—is subject to still another orbital motion, of a quite different kind. Both have a common revolution about a third body, a large, distant, and dark companion or primary, in a period of about 130 years. The size of this orbit around the common centre of gravity is about equal to that of Uranus around the sun. The plane of the orbit is inclined about 20° to our line of vision. Algol transited the plane passing through the centre of gravity perpendicular to this line of vision in 1804 going outwards, and in 1869 coming inwards. Calling the first point the ascending node, the position-angle, reckoned in the ordinary way, is about 65°. The orbit is sensibly circular, or of very moderate eccentricity. The longest diameter of the projected ellipse, measured on the face of the sky, is about 2″·7. A necessary consequence of this theory is an irregularity of proper motion with an amplitude of something over a fifth of a time-second in right ascension, and nearly one and a half seconds in declination; the middle point being the centre of gravity of Algol, and the distant unknown companion, and the uniform proper motion of the latter being − 0·0010s. and + 0″·0120 annually, in the two co-ordinates respectively. The annual parallax of the star is about 0″·07. The mean period of light variation is 2d. 20h. 48m. 56·00s." It seems very probable, from Dr. Chandler's communication, that the inequalities in the periods of other variables of the Algol type will admit of a similar explanation.

THE SUN-SPOTS OF FEBRUARY.—Some facts with regard to the dimensions of the recent sun-spots appear in the March number of the *Observatory*. The group of spots apparently connected with the great magnetic disturbance of February 13–14, and the aurora which was visible at a large number of places on the latter date, was first seen on the east limb of the sun on February 5. It passed the central meridian six days later, and disappeared round the west limb on February 17. "The total spotted area measured on the photographs taken at Greenwich on February 13, when the group reached its maximum, was no less than 1/350 of the sun's visible hemisphere. At Greenwich the area of spots is measured in millionths of the sun's visible hemisphere, and this extensive group had an area of 2850 millionths, corresponding to 3360 millions of square miles. The centre of the group was then at 260° long., and in lat. − 23°. The group was a broad band extending over 22° of longitude in length and 10° of latitude in width, corresponding roughly to a greatest length of 150,000 miles and a width of 75,000 miles. The large central spot of the group was 15° in length in longitude and 8° in width in latitude. The spot-group is the largest ever photographed at Greenwich, and is the largest which has appeared on the sun since 1873."

A NEW COMET.—Prof. Lewis Swift, of the Warner Observatory, discovered a comet on March 6 in R.A. 18h. 59m., and N.P.D. 121° 20′. Unfortunately the comet is at present too far south to be seen in these latitudes.

PROF. KRUEGER (*Astronomische Nachrichten*, No. 3077) contributes an important paper on the determination of the perturbations set up in the motions of periodic comets as they approach the sun, owing to their proximity to the planets.

PHOSPHOROUS OXIDE.

IN addition to the well-known pentoxide formed when phosphorus is burnt in air or oxygen, a second oxide of phosphorus has long been surmised to exist. Very little, however, has hitherto been known concerning this second oxide. It is usually described in current chemical literature as a white amorphous powder of the composition P_2O_3, very voluminous, somewhat more volatile and more readily fusible than the pentoxide P_2O_5, and instantly dissolved with great rise of temperature by water, with formation of phosphorous acid. During the last three years an investigation has been carried out in the laboratory of the Royal College of Science by Prof. Thorpe and the writer, which has resulted in showing that phosphorous oxide is a substance possessing properties entirely different from these. Full details of this work have recently been laid before the Chemical Society, but a short account of the manner in which the pure oxide has been isolated in quantity, of its somewhat remarkable properties, and of a few of its more important reactions, may, perhaps, not be uninteresting to readers of NATURE.

Properties of Phosphorous Oxide.

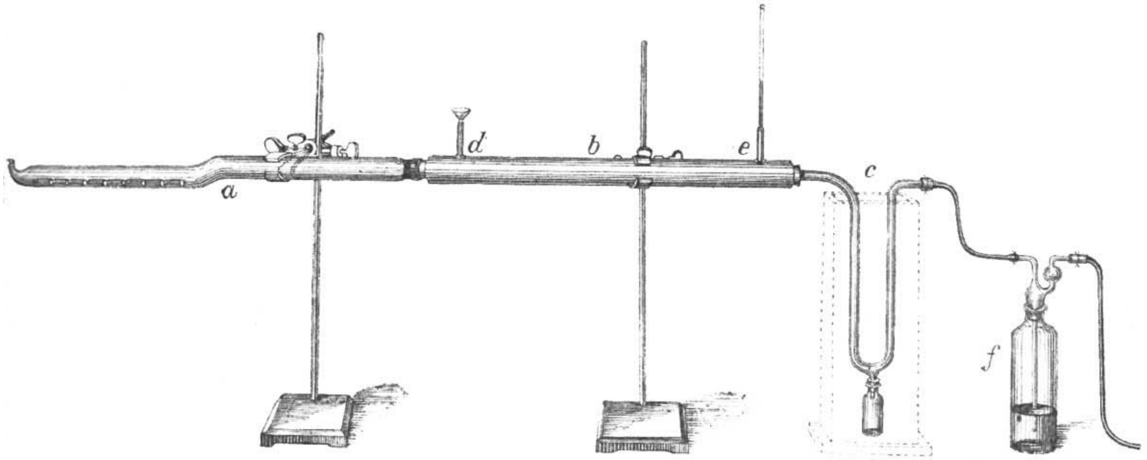
Before describing the mode of preparing the oxide, it will be advisable to briefly indicate the external appearance and essential properties of the substance. Phosphorous oxide is not an amorphous powder, but, at temperatures not exceeding 22° C., a pure white crystalline solid, compact and heavy, soft and wax-like in character. Its most striking property is the ease with which it melts, the warmth of the hand which holds the vessel containing it being more than sufficient to convert it to the liquid state. Its melting point is 22°·5 C., hence upon a warm summer's day or when placed in a warm room it takes the form of a clear, colourless liquid, very mobile, but somewhat heavy. It is best preserved in sealed glass tubes, the air of which has been replaced before the introduction of the oxide by carbon dioxide or nitrogen in order to avoid the action of the oxygen contained in air, which rapidly converts phosphorous oxide to phosphoric oxide. When such a tube containing the liquid oxide is cooled by immersing it in cold water or allowing it to stand in a room of ordinary temperature (17°–

20° C.) the oxide rapidly resolidifies in a most beautiful manner, large crystals shooting out in all directions until the whole is one compact mass of interlacing crystals. When the liquid is heated in a distillation flask previously filled with one of the indifferent gases carbon dioxide or nitrogen, it soon commences to boil, and the vapour condenses in the condensing tube and the unchanged oxide runs down into the receiver placed to intercept it in the form of liquid, which eventually condenses to the solid again. Its boiling point is 173°·1 C.

The vapour of phosphorous oxide possesses a very characteristic odour, which appears to be the same as that so noticeable about a lucifer-match manufactory. Owing to its great volatility, both the solid and the liquid are constantly vapourizing, even at the ordinary temperature, and hence the odour is always strongly marked in their neighbourhood.

Phosphorous oxide may also be obtained by spontaneous evaporation *in vacuo* in beautiful large isolated crystals, probably belonging to the monoclinic system, which are quite colourless and transparent, and very highly refractive; crystals have frequently been obtained in this manner an inch in length and broad and thick in proportion, showing numerous prism and pyramid faces. Similar crystals are obtained when solutions of the oxide in carbon bisulphide, chloroform, ether or benzene, in which the substance readily dissolves, are evaporated out of contact with the air.

Instead of reacting with violence with water, as appears to have been generally supposed, phosphorous oxide is comparatively indifferent to that liquid, only dissolving with great slowness. If a few drops of the liquefied oxide are dropped into water of about the same temperature they at once fall to the bottom of the tube, and the two liquids do not mix. If the water is at the ordinary temperature the oxide solidifies as it falls to the bottom. A few grams of the oxide, either liquid or solid, require several hours for complete solution. The solution contains phosphorous acid. When phosphorous oxide is warmed with water to a temperature just below 100°, a violent reaction of an entirely different nature occurs; spontaneously inflammable phosphoretted hydrogen is evolved with a loud explosion, and red phosphorus and phosphoric acid are largely formed.



Apparatus employed for the preparation of phosphorous oxide.

Preparation of Phosphorous Oxide.

It is quite a mistake to suppose that when phosphorus is burnt in a combustion-tube in a *slow* current of air the lower oxide, and not phosphorus pentoxide, is produced. Scarcely a trace of phosphorous oxide is obtained under these circumstances, the white amorphous powder deposited being pentoxide. It is only when the current is at all rapid that phosphorous oxide commences to be formed. Its advent is at once apparent, as it crystallizes all along the upper portion of the horizontal combustion-tube in beautiful feathery crystals, which at once melt if the finger is laid upon the exterior of the tube, while the pentoxide settles out along the bottom of the tube. After several less successful attempts to devise a method of producing these volatile crystals in larger quantity, and of separating them entirely from the pentoxide, a method has at length been found by which as much as twenty-eight grams of the pure oxide have been obtained in an experiment of five hours' duration.

Two sticks of phosphorus are cut into pieces about an inch and a half long, and placed in a glass tube bent into the shape shown at *a* in the figure, so as to retain the phosphorus when in the melted condition. The tube should be of 1½-inch bore, and should be made from *new* soft glass tubing, which is quite hard enough to stand the heat of burning phosphorus. The tube is drawn out somewhat, but quite open, at the end where the air is to be admitted, and at the other is narrowed slightly, so as to fit into the condenser *b*, a tight joint being obtained by means of a caoutchouc ring or a little bicycle cement. This condenser, *b*, is intended to retain the phosphorus pentoxide and any free phosphorus produced during the combustion, and is maintained at such a temperature that the phosphorous oxide passes uncondensed through it. It is therefore constructed of brass instead of glass, and is made double, that is, with an outer jacket also of brass, so that the space between the two brass tubes may be filled with water of the required temperature. This water may be run in by means of a funnel through a small vertical tube, *d*, a second such tube, *e*, serving for the introduction of a thermometer. The size of condenser found most convenient is 2 feet in length, and the inner brass tube has a bore of 25 millimetres. At the end of the condenser furthest from the phosphorus, a plug of glass wool about half an inch long is inserted, the fibres being arranged transversely as much as possible; such a plug forms an excellent means of filtering off any pentoxide which would otherwise escape into the phosphorous oxide condenser, especially after the first few minutes of the combustion, when its meshes become loosely filled with porous pentoxide. Directly into the end of the brass condenser fits tightly, by means of a cork annulus, the large glass U-tube condenser, *c*, in which the phosphorous oxide is condensed. The yield of oxide appears to depend somewhat upon the shape and dimensions of this condenser, that found most advantageous having the shape shown in the diagram, a height of 35 centimetres from the bottom of the bend, and an internal bore of 14 millimetres. A short vertical tube is fused on at the bend, and passes down into a bottle, into which the oxide may be melted at the end of each combustion. The whole condenser is surrounded by a tall wooden box, indicated by dotted lines in the figure, containing pounded ice. To the end of the condenser is attached a wash-bottle, *f*, containing sulphuric acid, which serves to prevent access of moisture to the oxide condensed in the U-tube, and also to measure the rate of the current of air drawn through the apparatus by the water-pump.

In making a preparation, as soon as the phosphorus, dried by blotting-paper, has been introduced and the tube containing it attached to the brass condenser, which at first is quite cold, the phosphorus is warmed to the igniting point and the pump set working by turning on the water-tap to which it is firmly attached. After about ten or fifteen minutes, crystals begin to make their appearance in the U-tube; the oxide then rapidly collects in the form of a waxy mass. The best refrigerator for the U-tube is pounded ice; if salt is mixed with it, the oxide condenses so rapidly in the first cooled portion of the condenser as to form a bridge and stop the operation until it is melted down. When nearly half of the phosphorus is burnt, the brass condenser is warmed by pouring in water heated to about 70°–80° C., and the condenser is maintained at this temperature until about three-quarters of the phosphorus has been burnt, when the operation is stopped by slowly turning off the water working the pump.

When phosphorus is burnt under these conditions, three oxides are produced; more or less of the red suboxide P_4O is always deposited in the immediate neighbourhood of the burning phosphorus, a certain amount of pentoxide is formed and retained in the glass tube beyond the seat of combustion and in the brass condenser, and phosphorous oxide is produced in large quantity, and, being considerably more volatile, is carried forward to the cooled condenser, any which may be deposited in the brass condenser during the earlier stages of the combustion being carried along into the U-tube in the current of escaping nitrogen when the warm water is introduced into the brass condenser. Scarcely a trace of pentoxide escapes through the glass wool filtering plug, the product in the U-tube being almost pure phosphorous oxide. In the course of five hours three such charges of phosphorus may be burnt out and the total phosphorous oxide produced, which should amount to at least twenty grams, can be condensed in the same U tube, the product from each charge being melted down into the bottle so as to prevent choking of the tube. In order to free the product from any traces of impurity, it should be distilled in a slow current of carbon dioxide, when it condenses in the receiving tube as an absolutely clear liquid which soon solidifies to a snow-white mass of crystals. The tube should be at once sealed and, for a reason which will be found under the *Action of Light*, kept in the dark.

Molecular Composition of Phosphorous Oxide.

Quantitative analysis of the substance whose properties and mode of preparation have just been described of course yields numbers which agree with the empirical formula P_2O_3. But as the oxide is volatile it was of the first importance to determine its vapour density, with the view of obtaining information regarding its molecular weight. This determination was the more interesting from the fact that Prof. Victor Meyer had previously found that the analogous oxides of arsenic and antimony gave vapour densities corresponding to the double molecular formulæ As_4O_6 and Sb_4O_6, and also from the fact that the molecule of phosphorus itself is found to contain four atoms. The vapour density was determined by Hoffmann's well-known method in the Torricellian vacuum at the temperatures of boiling amyl alcohol (132°), oil of turpentine (159°) and aniline (184°). The numbers obtained from several such determinations are in perfect accordance with the molecular weight corresponding to the double formula P_4O_6. This result has been fully confirmed by a determination of the molecular weight by the totally different method of Raoult, which depends upon the degree of lowering of the freezing point of a solvent, in this case benzene, by the introduction of a small quantity of the substance undergoing investigation.

Hence phosphorous oxide must be symbolized by the formula P_4O_6 and not P_2O_3, phosphorus thus resembling its family relatives arsenic and antimony in the nature of its lower combination with oxygen.

Physical Properties of Phosphorous Oxide.

The specific gravity of the solid oxide at 21° C., compared with water at 4° is 2·135, and that of the liquid oxide at 24°·8 is 1·9358. Hence there is about nine per cent. of contraction upon the passage of the liquid into the solid state.

A somewhat interesting result has been obtained from the determination of the specific volume, that is, the number obtained by dividing the molecular weight by the density at the boiling point. The actual density, of course, cannot be experimentally determined at the temperature of ebullition, but by making a careful determination of the rate of expansion and knowing the density very precisely at some lower temperature the density at the boiling point can be calculated. The value thus found for the specific volume was 130·2. Now, phosphorus is known to possess two specific volumes; one in the state of combination (as determined from its halogen derivatives) and which is somewhere about 25·3, and another when in the free state, which is approximately 20·9. Oxygen, too, is usually supposed to have two values, one of 7·8 when it is linked to two different atoms, single linkage as it is termed, and another of 12·2 when doubly linked to one and the same atom of another element. If we subtract six times 7·8, that is deduct the specific volume due to six atoms of oxygen, from the specific volume 130·2 of phosphorous oxide, we arrive at the number 83·4 for four atoms of phosphorus, or 20·9 for that of one atom. If any of the oxygen atoms were doubly linked the number would be considerably less than 20·9, hence this number represents the greatest possible value of the phosphorus in phosphorous oxide.

It would appear, therefore, that the phosphorus in phosphorous oxide possesses the same specific volume as free phosphorus itself, a result of interest in view of the fact revealed by the determinations of molecular weight that there are four atoms of phosphorus in the molecule of the oxide just as there are in the molecule of free phosphorus itself.

The liquid oxide, considering that it contains such a highly refractive substance as phosphorus, possesses a remarkably low power of refracting light. Its refractive index at 27°·4 C. is only 1·5349 for the red line of lithium, and 1·5614 for the blue hydrogen line G. Not only is the refractive index of phosphorus (2·0677 for the red hydrogen line C) enormously reduced by its combination with oxygen, but the length of the spectrum is reduced to about one-fifth.

Action of Light.

Phosphorous oxide, in the white wax-like solid form in which it usually condenses after distillation, is remarkably sensitive to light. Ten minutes exposure to bright sunshine suffice to turn it red, and after half an hour it is rendered quite dark red. The red substance which is formed is the red modification of phosphorus, but even after several months' exposure the amount produced has never been found to exceed 1 per cent. of the weight of the oxide. The beautiful isolated crystals obtained by sublimation *in vacuo* appear to be unaffected by light, but it is a curious fact that if one of them is melted by the warmth of the hand, and the liquid globule afterwards suddenly cooled to the wax-like form, the latter becomes red on exposure to daylight. Whether the reddening is due to the conversion of small quantities of admixed yellow phosphorus into red phosphorus, or to the decomposition of the waxy form of the oxide by light, there is not yet sufficient data to determine.

Action of Heat.

It has been seen that the oxide boils without decomposition at 173°·1. It may be heated in a closed tube to considerably over 200° without change. It commences to decompose, however, between 210° and 250°, becoming turbid from the separation of solid decomposition products, one of which is free phosphorus, which becomes more and more deeply coloured until at 300° it is quite red. At about 400° the oxide is totally decomposed into solid products, consisting of both yellow and red phosphorus and phosphorus pentoxide. Occasionally, when only the lower half of the tube has been immersed in the heating bath, the formation of crystals has been observed in the cooler portion of the tube, which appear to be identical with some described in a previous communication to the Chemical Society which gave numbers on analysis agreeing with the formula P_2O_4, and which yielded a solution with water capable of reducing mercuric chloride to calomel. Hence the final decomposition by heat may be expressed by the equation

$$5P_4O_6 = 6P_2O_5 + 8P,$$

but under suitable circumstances the intermediate formation of the tetroxide may occur according to the equation

$$2P_4O_6 = 3P_2O_4 + 2P.$$

Action of Oxygen.

Phosphorous oxide takes up oxygen spontaneously at the ordinary temperature. It is probable, however, that the oxygen only reacts in the cold with the vapour. For if a small quantity of the oxide is placed at the bottom of a glass tube closed at one end and previously filled with oxygen, and the tube is sealed and left in the dark in an upright position, the oxide is gradually converted to a voluminous mass of pentoxide, which is deposited in a most beautiful manner in regular annuli all up the tube to the very top. When the oxide is placed in contact with oxygen in an apparatus in which the pressure can be rapidly diminished, the oxidation is seen to be accompanied by a phosphorescent glow, flickering up and down throughout the whole inclosed space, similar to that which occurs under the same circumstances with phosphorus itself. Moreover, this phenomenon is observed with the purest specimens distilled *in vacuo*. If the temperature is increased, the phosphorescence is brought about at pressures near the atmospheric, and if it is raised to 70° C., phosphorescence gives place to actual combustion, which, however, may be at once reduced to mere phosphorescence by diminishing the pressure. If the oxide is thrown into oxygen warmed to about 50°, it immediately burns to the pentoxide with a most brilliant flash of flame.

Action of Halogens.

When phosphorous oxide is thrown into a vessel containing chlorine gas, it instantly takes fire and burns with a pale green flame. If chlorine is led over the oxide at the ordinary temperature, violent combustion also occurs; but if the vessel containing the oxide is cooled by ice, the reaction occurs in a more moderate manner. The product is a clear liquid which is found to be a mixture of phosphorus oxychloride, $POCl_3$, which may be distilled off, and metaphosphoryl chloride, PO_2Cl, which remains as a viscous residue after the distillation of the phosphorus oxychloride. The reaction occurs in complete accordance with the equation

$$P_4O_6 + 4Cl_2 = 2POCl_3 + 2PO_2Cl.$$

Bromine also acts with considerable violence upon the oxide, generally with incandescence. Analogous products are eventually obtained as in the case of chlorine; but if the experiment is so arranged that the vapours of the two substances only are allowed to react at the ordinary temperature, an intermediate reaction occurs with deposition of annuli of large and very perfect crystals of phosphorus pentabromide, PBr_5, phosphorus pentoxide being also formed at the surface of the phosphorous oxide.

Iodine only slowly reacts with the oxide, and best when the two substances are dissolved in carbon bisulphide and the solution heated in a sealed tube. On cooling, orange-red crystals of P_2I_4 separate out.

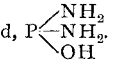
Action of Sulphur—Formation of a Sulphoxide of Phosphorus.

Sulphur reacts with the oxide in a most interesting manner, producing a beautifully crystalline addition compound of the empirical formula $P_2O_3S_2$. The reaction is best carried out in a sealed tube, about five grams of the oxide and the corresponding quantity of sulphur being placed together in the tube, which has previously been filled with carbon dioxide or nitrogen. The tube is fixed upright, and its lower portion, containing the mixture, is heated in a glycerine bath. No reaction occurs, the two liquids remaining in separate layers, until a temperature in the neighbourhood of 160° is attained, when sudden and very violent combination takes place, the tube being usually shattered into fragments if more than 5 grams of the oxide are employed. The sulphoxide produced is a pale yellow solid substance which melts at about 102°, and boils without decomposition at 295°. When heated *in vacuo* it sublimes largely in the form of tetragonal prisms of considerable size, quite colourless and transparent; a certain amount frequently condenses in a vitreous form, which eventually devitrifies into feathery aggregates of the tetragonal prisms. Occasionally long needles, elongated tetragonal prisms, are formed. A very slight residue usually remains of sulphur, to which the yellowish colour of the crude product is probably due. The sulphoxide is soluble in carbon bisulphide, and the solution deposits it again in tetragonal prisms on evaporation.

As phosphorus sulphoxide is undecomposed even at 400° C., it has been found possible to determine its vapour density by Victor Meyer's method in an atmosphere of nitrogen. The numbers obtained agree with the double formula $P_4O_6S_4$. Hence phosphorus sulphoxide is a direct sulphur addition product of phosphorous oxide.

It is deliquescent, and is decomposed by water with liberation of sulphuretted hydrogen and formation of phosphoric acid.

Other Reactions of Phosphorous Oxide.

Ammonia gas, when led over melted phosphorous oxide, causes immediate ignition of the mass. When the oxide is dissolved in ether, however, the action is more manageable, and a new white solid compound is formed. This compound is the diamide of phosphorous acid,  $P\begin{array}{l}\diagup NH_2\\ -NH_2\\ \diagdown OH\end{array}$. It is an amorphous powder which dissolves instantly in water with production of flame. Dilute hydrochloric acid liberates pure non-spontaneously inflammable phosphoretted hydrogen from it, owing to the decomposition, at the high temperature brought about by the reaction, of the phosphorous acid first produced.

Hydrochloric Acid gas converts the oxide into phosphorus trichloride and phosphorous acid, the former being readily decanted from the latter at the close of the experiment.

$$P_4O_6 + 6HCl = 2PCl_3 + 2H_3PO_3.$$

Concentrated *sulphuric acid* deflagrates violently with phosphorous oxide with production of flame, formation of phosphoric acid, and liberation of sulphur dioxide.

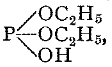
Caustic alkalies, when tolerably concentrated, at once decompose the oxide with production of a flame of burning phosphoretted hydrogen, red phosphorus being deposited, and a phosphate formed.

Sulphur chloride and *phosphorus pentachloride* respectively react with great energy with the oxide, the resulting liquid products being immediately raised to the boiling-point. When the reactions are performed in vessels cooled by ice, the products may be collected and examined. Sulphur chloride yields a mixture of oxychloride and sulphochloride of phosphorus,

$$P_4O_6 + 6S_2Cl_2 = 2POCl_3 + 2PSCl_3 + 2SO_2 + 8S.$$

Phosphorus pentachloride produces a mixture of oxychloride and trichloride of phosphorus,

$$P_4O_6 + 6PCl_5 = 6POCl_3 + 4PCl_3.$$

Ethyl alcohol instantly sets fire to phosphorous oxide. The reaction may readily be moderated, however, by cooling the vessel by ice, and under these circumstances a new liquid, diethyl phosphorous acid  $P\begin{array}{l}\diagup OC_2H_5\\ -OC_2H_5\\ \diagdown OH\end{array}$, is produced. This liquid possesses a strong garlic-like odour, boils at 184°–185°, and has a specific gravity of 1·0749 at 15°·5.

An account of the properties of phosphorous oxide would not be complete without a reference to its physiological action. Most people are aware that persons engaged in lucifer-match making occasionally suffer terribly from disease of the lower jaw, and it is found that this is due to the direct action of the fumes upon the bone. It would appear that this deplorable action is directly traceable to the vapour of the volatile phosphorous oxide now described, for this oxide is found to be largely formed when phosphorus oxidizes without igniting; and if any benefit in the way of increased precautions against such action should follow from the further knowledge now gained concerning this substance, none will rejoice more heartily than those who have attempted to place its chemical history upon a surer foundation.

A. E. Tutton.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Mr. George B. Grundy, B.A., Brasenose College, has been elected to a Geographical Studentship (see November 19, 1891, p. 70). This student, after preliminary study at Oxford, or at some other place appointed by the electors, will be expected to reside at least three months in the region he is investigating, and to forward the results of his work to the Royal Geographical Society.

A meeting of the Ashmolean Society was held in the Museum on Monday, March 7, Mr. E. B. Poulton, F.R.S., in the chair. The Rev. F. J. Smith, Trinity College, Mellard Lecturer, was prevented by illness from giving his paper on some of the uses of photography in scientific research. Mr. Veley, University College, read a paper on some chemical transformations of nitric and nitrous acids.

Mr. F. E. Weiss, Assistant Professor of Botany at University College, London, has been appointed Professor of Botany at Owens College, Manchester.

Mr. Wyndham R. Dunstan, the Director of the Research Laboratory connected with the Pharmaceutical Society, has been elected Lecturer on Chemistry at St. Thomas's Hospital Medical School, in succession to the late Dr. Bernays.